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REVIEW ARTICLE

Macaques in Farms and Folklore: Exploring the Human–Nonhuman Primate Interface in Sulawesi, Indonesia

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The island of Sulawesi is an ecologically diverse and anthropogenically complex region in the Indonesian archipelago; it is home to multiple macaque species and a key locus of human–nonhuman primate interconnections. Here, we review the ethnoprimatology of Sulawesi by exploring two primary domains of the human–macaque interface: overlapping resource use and cultural perceptions of macaques. Crop raiding is the primary form of overlapping resource use. While the raiding of cacao plantations predominates in Central and South Sulawesi, subsistence crops (e.g., sweet potato and maize) are most vulnerable on Buton, Southeast Sulawesi. Despite this overlap levels of conflict are generally low, with farmers showing considerable tolerance. This tolerance can be explained by positive perceptions of the macaques despite their crop raiding behavior, and the finding that in some areas macaques figure prominently in local folklore, hence affording them protection. These findings provide some hope for the future management and conservation of these endemic macaques. Am. J. Primatol. 72:848–854, 2010. © 2010 Wiley-Liss, Inc.

Key words: ethnoprimatology; Sulawesi; macaque; crop raiding; folklore; local tolerance

INTRODUCTION

Ethnoprimatology [Sponsel, 1997] is an approach that draws from primate socioecology, ethnoecology/environmental anthropology, and conservation biology. By envisioning human and nonhuman primates as members of a dynamic ecosystem, ethnoprimatology is well positioned to unravel the multifaceted ways that human and nonhuman primates interconnect [Fuentes, 2006]. Ethnoprimatology also has an applied dimension; it is concerned with the ramifications of human–nonhuman primate interactions for the long-term survivability of nonhuman primates and their habitats [Riley et al., 2010].

The purpose of this paper is to highlight the ethnoprimatology of the Indonesian island of Sulawesi. While the ecology of Sulawesi macaques has long been of interest to scholars in the last decade basic ecological questions have been expanded to include explorations of how humans and Sulawesi macaques interconnect, both ecologically and culturally [Jones-Engel et al., 2005; Priston, 2005; Riley, 2005]. We begin by illuminating the context of the human–nonhuman primate interface in Sulawesi by situating the macaques within the anthropogenic complexity of the island. Drawing from our field research from Central and South Sulawesi (Riley) and the island of Buton in the southeastern province (Priston), we then review the current state of knowledge on two major facets of Sulawesi's human–macaque interface: crop raiding and macaques in folklore. We conclude with a discussion of the conservation implications of this interface, and consider possible avenues for future scholarship.

THE SULAWESI CONTEXT: MACAQUES AND ANTHROPOGENIC COMPLEXITY

The island of Sulawesi is located within Wallacea; a unique biogeographical zone recently classified as a ''Biodiversity Hotspot'' [Myers et al., 2000] due to its great diversity of endemic species. For example, of the 127 mammals indigenous to Indonesia, 79 (62%) are endemic to Sulawesi [Whitten et al., 2002]. Among those endemic mammals are the Sulawesi macaques, originally classified as seven species: *Macaca nigra*, *M. nigrescens*, *M. maura*, *M. tonkeana*, *M. hecki*, *M. ochreata*, and *M. brunnescens* [Fig. 1; Fooden, 1969]. The IUCN [2008] currently recognizes six species; *brunnescens* is considered a subspecies of

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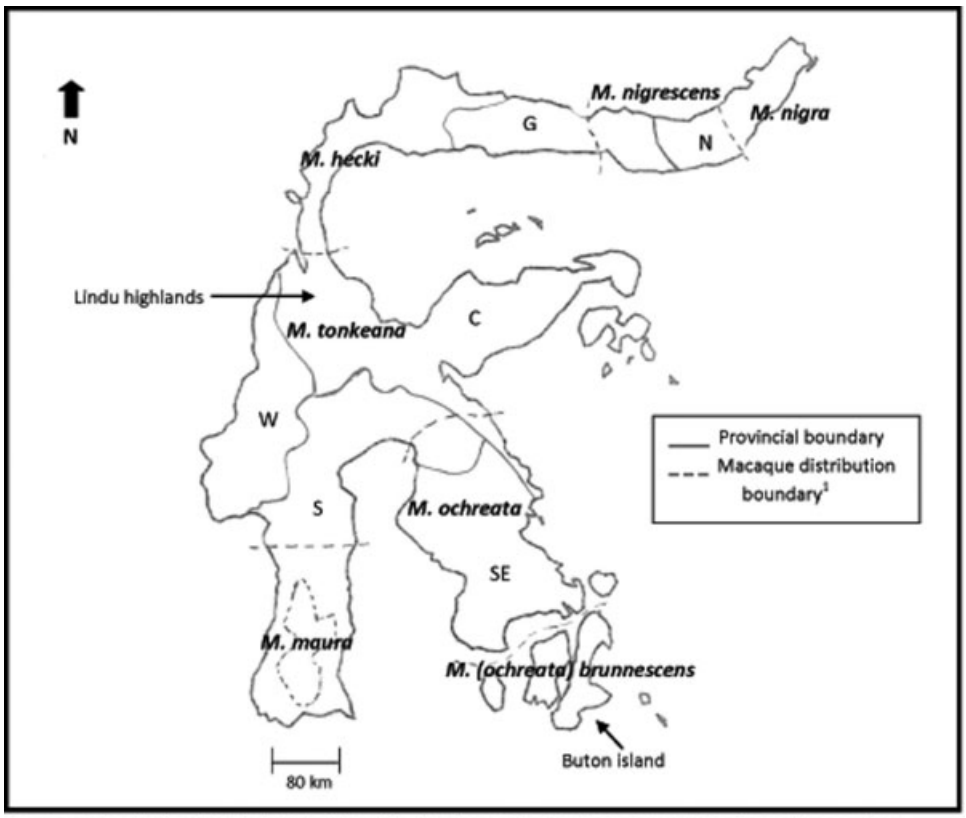

Province abbreviations: S = South; W = West; SE = Southeast; N = North; C = Central; G = Gorontalo province;
[1] Sources: Fooden, 1969; Bynum et al., 1997; Riley et al., 2007; IUCN, 2008

Fig. 1. Map of Sulawesi showing provincial boundaries, the distribution of the Sulawesi macaque taxa, and the location of our field sites (Lindu highlands and Buton).

M. ochreata. Although originally exhibiting an allopatric distribution across the island, there is evidence that several species overlap ecologically at the borders of their respective ranges [Bynum et al., 1997; Riley et al., 2007; Supriatna et al., 1992], with reports of interspecific hybridization [Bynum et al., 1997; Froehlich & Supriatna, 1996; Watanabe et al., 1991].

Wallacea's classification as a Biodiversity Hotspot also stems from its ecology undergoing tremendous alteration from human activities [Mittermeier et al., 1999]. Sulawesi's human population of over 14,000,000 is unevenly distributed across the island, with highest population densities in the southern and northern provinces (129 and 132 individuals/km^2, respectively), compared to Central and Southeast Sulawesi (35 and 48 individuals/km^2) [BPS, 2000]. These highly dense areas are also where the two most threatened Sulawesi macaque species (*Macaca maura* and *M. nigra*) occur (Fig. 1).

Sulawesi's human population is composed of seven major ethnic groups, which are divided in relation to geography, subsistence, language, and religion (Table I). Traditional forms of subsistence range from swidden agriculture to fishing and/or seafaring (Table I; Davis, 1976). Large-scale conversion of forest has accelerated in the last four decades due to the emergence of government supported enterprises including commercial logging, the transmigration program, and development of cash crop industries [Whitten et al., 2002]. Many of the ethnic groups now engage in wet-rice agriculture, and most practice plantation agriculture of cash crops including coffee, cacao, palm oil, and cloves. A recent study by Cannon et al. [2007] reports that 80% of Sulawesi's forests have been altered and/or destroyed, and of that remaining, only 30% is in good condition [i.e., ''forest canopy unbroken by large clearings with only scattered signs of human activity''; Cannon et al., 2007: 749]. Despite the Sulawesi macaques' ability to persist in human-modified habitats [O'Brien & Kinnaird, 1997; Riley, 2008], all of the species are threatened by habitat loss or hunting [Bynum et al., 1999; IUCN, 2008; Lee, 1999] and population declines of 75% have been witnessed [e.g., *M. nigra*; Rosenbaum et al., 1998].

METHODS

We draw primarily from our research on Tonkean macaques in Lore Lindu National Park (LLNP) in Central Sulawesi (Riley) and Buton macaques found on the island of Buton off the

TABLE I. Major Ethnic Groups of Sulawesi (Adapted from Davis, 1976)

Language/ethnic group	Dominant religion	Traditional subsistence	Provincial location
1. Minahasa	Christianity	Plantation and mixed agriculture	North (east)
2. Gorontalo-Tomini	Islam	Mixed agriculture	Gorontalo
3. Toraja			
a. Kaili	Islam	Mixed agriculture	Central (west)
b. Upland Kaili and Bare'e	Christianity	Upland swidden and mixed	Central (west and central)
c. Toraja	Christianity	Mixed agriculture	South (central)
4. Bugis-Makassar			
a. Bugis	Islam	Lowland agriculture, seafaring, commerce	South
b. Makassarese	Islam	Lowland agriculture, seafaring	South
c. Mandar	Islam	Lowland agriculture, seafaring	West
5. Luwuk-Banggai	Mixed	Swidden, fishing	Central (east)
6. Bunku-Mori	Islam	Swidden, fishing	Southeast
7. Muna-Buton	Islam	Swidden, fishing	Southeast (islands)

southeastern coast of Sulawesi (Priston) (Fig. 1). In Lore Lindu National Park, ecological and ethnographic methods were used to investigate the human–macaque interface. Ecological methods involved quantitative measurements of crop loss caused by Tonkean macaques and two other forest species, squirrels (*Prosciurillus sp*.) and rats (*Taeromys sp*.) in 11 cacao (*Theobroma cacao*) plantations. The number of cacao fruits consumed by each species and the number of remaining cacao fruit on each tree were enumerated every 2 weeks over the course of a 9-month period. Ethnographic methods included semi-structured interviews with the owners of these 11 plantations, focusing on their perceptions of the frequency of crop raiding and its impact on their livelihoods [see Riley, 2007], as well as with elders who knew the details of macaque folklore [Riley, 2010]. Semi-structured interviews involve a formal set of questions, but there is also scope for exploring other relevant information with additional, impromtu questions.

In Buton, quantitative measurements of crop loss caused by Buton macaques, and other vertebrates (e.g., Sulawesi warty pig *Sus celebensis*, squirrels *Prosciurillus sp*, and rats *Taeromys sp*.) were recorded in 73 farms over two 3-month periods (2002 and 2003) [Priston, 2005], and further measurements were taken over the course of 18 months (2007–2008) in 381 farms [Priston, unpublished data]. In the first study period (2002–2003), crop loss was measured using nine 10×2 m transects in each farm within which every crop stem was recorded and scored for the presence of damage (from 0 (no damage) to 5 (completely destroyed)) [see Priston, 2005 for details]. In the second period (2007–2008), all instances of crop damage were recorded for each farm (i.e., the crop damaged, number of stems/area damaged, and species responsible) [Priston, unpublished data]. Semi-structured interviews were also conducted with the owners of those farms covering demographic/socioeconomic factors, perceptions of crop raiding, impacts on livelihoods and attitudes towards wildlife [Priston, 2005; Priston & Lee, in prep]. Focus group discussions were also held with various members of the community including men, women, and elders [Priston, 2005; Priston, unpublished data].

The research reported within adhered to the ASP ethical guidelines for the treatment of non-human primates, was approved by the appropriate institutional animal care and use committees (i.e., University of Georgia IACUC, University of Cambridge, UK and Oxford Brookes University, UK), and followed Indonesia's laws for foreign research.

HUMAN–MACAQUE INTERCONNECTIONS ON SULAWESI

Human–macaque interconnections on Sulawesi can be categorized into the following domains: pet ownership and disease transmission; overlap and conflict in resource use; and cultural perceptions of macaques. It is important to note that many of these domains are interrelated, and hence can overlap. For example, disease transmission between macaques and humans can result from pet ownership [e.g., transmission of measles from humans to pet macaques; Jones-Engel et al., 2001] as well as from increased human–macaque contact due to overlapping resource use [e.g., malaria in macaques and humans in Malaysia due to increasing deforestation; Vythilingam et al., 2008]. We nonetheless find these categories useful in capturing the nature of the human–macaque interface on Sulawesi. Here we focus on the latter two domains: overlapping resource use and cultural perceptions of macaques.

Human–Macaque Overlap in the Forest–Farm Matrix

The primary form of overlapping resource use between humans and Sulawesi macaques is crop raiding. Crop raiding is a long-standing human–macaque

ecological interaction; interviews with villagers in upland Central Sulawesi indicate that subsistence farmers experienced raiding macaques well before the Dutch conquest in the early 1900s [Riley, 2005]. In the postcolonial era, the development of plantation agriculture and cash cropping of highly palatable tree crops has exacerbated this potential for human–macaque conflict. Previously, crop losses that may have been accepted as part of general crop returns may now start to assume major perceptual importance in an evolving market economy [Lee & Priston, 2005].

One crop has proven to be of considerable concern: cacao (*Theobroma cacao*). In the mid-1980s, the Indonesian landscape experienced an enormous expansion of cacao acreage and production by smallholders, primarily on Sulawesi [Akiyama & Nishio, 1996]. This trend was exacerbated by the 1990s cacao price boom [Weber, 2003]. Today, Indonesia is currently the second largest producer of cacao (465,700 metric tons) [Franzen & Mulder, 2007], with 80% of it from Sulawesi. While cacao cultivated using a traditional forest farming system (i.e., grown under shade trees) is often encouraged over other forms of agriculture because it is viewed as more environmentally sound [Donald, 2004], the planting of this profitable crop adjacent to forested areas has proven to be disastrous in many areas, as Sulawesi macaques, and other wildlife, are attracted to the crop [Riley, 2007]. In fact, cacao raiding by macaques is a contemporary problem throughout much of Sulawesi [Riley, 2005, 2007; Riley et al., 2000, 2007; Supriatna et al., 1992]. The finding that entire groups of Tonkean macaques raid cacao regardless of levels of forest fruit availability and that frequency of guarding by farmers had no effect on crop raiding levels [Riley, 2007] point to a dismal future for the management of this problem.

On Buton island, the Muna-Buton macaque is found across a range of habitats from primary forest to forest–farm mosaic including extremely degraded farmland/shrub areas, where it raids both subsistence and cash/plantation crops [Priston, 2001, 2005]. Raiding parties range from single individuals to entire troops of over 45 individuals with all age–sex classes participating (Figs. 2 and 3) [Priston, 2001, 2005]. In this area, however, subsistence crops are of primary concern. Macaques living in forest–farm matrices devote over a third of feeding time to crop raiding; preferred crops being sweet potato, maize, and banana [Priston, 2005].

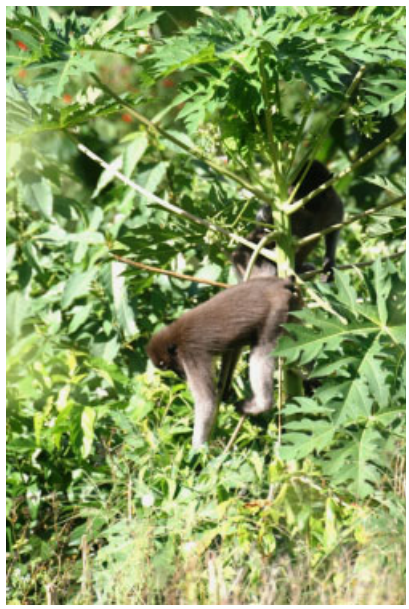

Fig. 2. Juvenile Buton macaques raiding a papaya tree. Photo credit: NEC Priston.

Fig. 3. Buton macaque group in a mixed garden. Photo credit: NEC Priston.

Situating Primates in the Minds and Culture of Humans

Cultural perceptions of primates vary enormously, through both space and time. In a number of regions from Africa to Tibet, primates are revered as guardians of human settlements, as bringers of good luck, as spirits of ancestors, and as embodiments of sexuality, fertility, wisdom, and fortune [Morris & Morris, 1966]. However, primates frequently symbolize the bestiality or dubious morality of the human species despite their positive religious associations [Morris & Morris, 1966]. The reasons behind such negative perceptions are multifaceted, but they may stem from primates' obvious morphological similarity to humans, giving rise to the view that they straddle the line between human and animal and are therefore dangerous creatures [Knight, 1999]. For example, the Matsigenka in Peru consider pygmy marmosets dangerous creatures because their behavior leads hunters astray and causes them to get lost in the forest [Shepard, 2002]. Negative attitudes toward primates can also be a function of the degree of contact with pest primates, and to a lesser extent with the risks perceived to result from direct contact [Hill, 2000; Naughton-Treves, 1996].

Farmers' perceptions of crop raiding macaques

An important component to ethnoprimatological research on the ecology of crop raiding is the simultaneous examination of farmer's perceptions regarding crop raiding and the factors that affect those perceptions. In the Lindu highlands, Riley [2007] found that while farmers reported macaques as the most frequent raiders, surveys of cacao plantations revealed that forests rats consume significantly more fruit than do Tonkean macaques. In Buton, although farmers' perceptions of crop raiding appear relatively accurate with estimates of between 0 and 90% damage per farm and a mean of 15.36% ± 23.56 SD (compared to actual amounts of 0–70% damage, mean of 10.35% ± 14.61 SD), closer examination reveals considerable variation among farmers [Priston, 2005]. Farmers experiencing low levels of crop damage were less accurate at estimating damage, whereas those experiencing medium or high levels were more accurate and even underestimated damage. Interestingly, while observations reveal that Buton macaques do raid trees of cacao and coconut, farmers do not perceive these crops to be vulnerable. Some farmers may even tolerate low levels of crop raiding as they see macaques as helping them harvest other crops, like cashew nuts: ''they eat only the fruit, letting the nut drop to the ground for us to collect'' (Butonese farmer).

Butonese farmers' perceptions regarding crop raiding neither appear to be related to socioeconomic factors, such as gender, age, income, and education, nor to farm characteristics, such as crop type. An exception is the amount of village land owned, with those with less land in the village itself (as opposed to farmland) having more negative perceptions [Priston, 2005; Priston & Lee, in prep]. One sociocultural factor in Buton that shapes farmers' perceptions is religion [Priston, 2005]. Although the majority of native Butonese are Muslim, there is a sizeable Balinese Hindu population who moved there as part of the Transmigration program, and who predominately engage in wet-rice agriculture. Because the macaques raid rice fields much less frequently than dryland crops, which are primarily managed by native Butonese, Hindus are less likely to experience problems with crop damage [Priston, 2005]. Nonetheless, interviews with farmers revealed that the Balinese Hindus were more likely than Muslims to report that they would kill monkeys if given the chance [Priston, 2005; Priston & Lee, in prep]. For example, monkeys are often killed opportunistically in the forest when hunting for wild pigs. Muslims, in contrast, claimed monkeys were like humans and needed food. Despite hating them, they did not want to kill them and certainly would not eat them as macaques are considered *haram* (forbidden). This level of tolerance, despite a significant level of crop raiding, has important implications for conservation of this species [Priston & Lee, in prep].

Macaques in folklore

In Sulawesi, macaques occupy a place in the cultural and ethnoecological narratives of a number of ethnic groups. Supriatna et al. [1992] noted that members of the Kajang tribe in South Sulawesi believe that their ancestors became monkeys, and therefore they avoid entering the forests so as to not disturb them. The authors contend that this belief helps ensure the persistence of primary forest and the moor macaques in that area; an important conservation outcome given that most of the Endangered moor macaque's range is composed of fragmented secondary or heavily altered forest [IUCN, 2008].

In the Lindu highlands, Central Sulawesi, Tonkean macaques figure prominently in the folklore of the Kaili Tado or *To Lindu* people [Riley, 2005]. Tonkean macaques are seen as kin and guardians of *adat* (traditional law); noted as biologically similar, and hence of human origin; and are recognized as key members of their shared ecological environments [Riley, 2010]. A specific story recounted by elders from one village tells of how a father left behind his young daughter to guard their house and gardens from raiding monkeys while he went to fish. According to the story, as soon as the father was gone, the monkeys began to raid their crops, and ultimately kidnapped the young girl. Upon hearing the commotion from the lake, the father went after the monkeys, and in his fight to rescue his daughter he left only a male and pregnant female macaque alive. The moral of the story is that the Lindu may not speak harshly or behave negatively toward the monkeys or they will become their enemies and return to wreak havoc in their lives. This folklore has considerable conservation significance in that it has resulted in a taboo against harming macaques they encounter in their gardens [Riley, 2010].

In Buton, although there is little traditional folklore surrounding the macaques or other animals on the island, elder men speak of sacred places in the forest, believing that the forest has some spiritual importance [Priston, 2005]. For example:

> Old men, long time ago, had magic knowledge, when they died they were buried in the forest, these are sacred graves in the forest—you are not allowed to touch or go near. You must not cut wood near the graves. It's like a test–the ghost is testing you, but if you take wood then you lose the test and that is bad. (Butonese Muslim, male, 76 yrs)

These perceptions may have resulted in the protection of certain forest areas; an outcome that positively affects the survivability of the Buton macaque since many of these areas often contain fruiting figs that provide a refuge for the macaques.

DISCUSSION: IMPLICATIONS FOR CONSERVATION

Protected areas (PAs) represent the dominant model for biodiversity conservation in Indonesia; 965 protected areas represent 12.5% of the total land cover [WRI, 2006]. In Sulawesi 29 protected areas cover 23% of montane forests and eight protected areas cover 8% of lowland forests [WWF, 2008]. While PAs may provide critical habitat for wildlife, rural communities that border them often must endure lost economic opportunities, exclusion from potential resources, and damage and depredation to crops and livestock by wildlife [De Boer & Baquette, 1998; Infield & Namara, 2001].

Collectively our research suggests that although humans and Sulawesi macaques exhibit considerable overlap in their uses of cultivated resources, the current level of resulting conflict is relatively low. We therefore find ourselves in a rather unique situation in which, at least for Central and Southeast Sulawesi, we have ''arrived'' before there is a major conservation issue. The key question is: how can the potential worsening of human–macaque overlap and conflict in Sulawesi be mitigated? One area of research that remains understudied is the relative importance of the loss of subsistence versus cash crops. Understanding how farmers perceive loss and livelihood will be important information to incorporate into management plans. One tactic that might help farmers better understand the actual extent of their losses, and at the same time potentially perpetuate their tolerance of the macaques, is to disseminate the results from crop raiding research to farmers and other community members. For example, at our respective field sites we both have held meetings in which we shared crop-raiding results with the owners of the gardens surveyed and other community members. In LLNP, the meeting participants were surprised to learn that forest rats cause significantly more damage to cacao gardens than the Tonkean macaques [Riley, 2007]. At both sites a number of meeting participants agreed that the crop losses to macaques were tolerable compared to their total harvest.

Research will also need to entail on-the-ground assessments of possible mitigation measures. For example, predicting crop raiding risk is an important arena for future research, both in terms of developing ways of accurately assessing impacts to crop yields [Priston, 2009] and designing methods for local people to use for rapid prediction of crop raiding risk [Priston & Underdown, 2009]. Other strategies for alleviating losses from crop raiding might include: the planting of alternative crops that are equally lucrative, yet of no interest to raiding wildlife; and, mimicking the bountifulness of cacao, papaya, and banana plantations by deliberately planting resources highly preferred by macaques at the forest margin. The adoption of the former, however, will require consideration of possible differences in harvesting costs and market prices between cacao and alternatives [Riley, 2007]. Ultimately, the challenge will be designing and implementing mitigation strategies that benefit all farmers, particularly when the raiding species are highly intelligent, adaptable, and raid in large numbers.

Further work exploring how mythology and folklore embody the macaques and simultaneously affect their survival will also be important. Although on the island of Bali local macaques are viewed as sacred [Wheatley, 1998], the Balinese Hindus who live on Sulawesi do not appear to retain this mythology, and hence, do not adhere to any taboos against killing the macaques they encounter [Jones-Engel et al., 2005; Priston, 2005; Priston & Lee, in prep]. Given its implications for our understanding of the impact of recent human migration on ethnoecology and for primate conservation, this topic warrants future ethnoprimatological investigation.

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